

REMARKS

Claims 1, 6, 11 and 12 are amended in order to more clearly define the claimed invention. It is respectfully submitted that no new matter is added. It is believed that this amendment is fully responsive to the Office Action mailed March 7, 2007.

The present invention is a simulation method for simulating an amount of occurrence of local flare which occurs in an exposure process in manufacturing a semiconductor device for use in optical corrections to obtain a more accurate optical image. The steps of the method are: dividing a layout of a photo mask into a plurality of areas, calculating an average value of light intensity in each of the areas, and estimating the amount of occurrence of local flare in each of the areas on the basis of each of the average values. When a circular-shaped light source is used, the average value of light intensity $\bar{I} = \sum_{k=1}^N F_k S_k S_k^* \dots$ and F_k is a weighting factor of diffracted light and S_k is the amplitude of the diffracted light, and $F_k = A_k / (\sigma^2 \pi)$ where A_k is the area shared between a circle C having a radius NA, the numerical aperture of the lens, and a circle S_k having a radius of the light source with respect to NA, and σ is the radius of the circular shaped light source with respect to NA. When a ring-shaped light source is used, $F_k = A_k / (\sigma_2^2 \pi - \sigma_1^2 \pi)$ where σ_1 is the inside radius and σ_2 is the outside radius of the ring-shaped light source with respect to NA.

Claims 1 - 12 are rejected under 35 USC §101 because the claimed invention is directed to non-statutory subject matter. Reconsideration and removal of this rejection is respectfully requested.

Regarding Claims 1 - 5, the Examiner alleges that the recited method appears to contain abstract ideas such as calculating an average value of light. Therefore, to be statutory, the claim must be directed to a practical application producing a concrete, useful and tangible result needed to support a practical application.

It is respectfully submitted that the simulation method, equipment, etc. of the present invention is used for estimating the amount of occurrence of local flare, which is then used for optical proximity correction, to correct the dimensions of the reticle and thereby obtain a more accurate optical image on a semiconductor device, as taught at page 1, line 25 to page 3, line 3 of the present specification. Therefore, it is respectfully submitted that such method, equipment, etc., of the present invention does produce a concrete, useful and tangible result.

In view of the above remarks, removal of this rejection is respectfully requested.

Claims 1 - 2, 5 - 7 and 10 - 12 are rejected under 35 USC §103(a) as being unpatentable over Takahashi (Kimitoshi Takahashi et al.; "Proximity effect correction using pattern shape modification and area density map", 2000, Journal of Vacuum Science and Technology B, Volume 18, Number 6, pages 3150 - 3157) in view of LaFontaine (Bruno La Fontaine et al.; "Analysis of Flare and its Impact on Low-k1 KrF and ArF Lithography", 2002, Proceedings of the SPIE, Volume 4691, pages 44 - 56). Reconsideration and removal of this rejection is respectfully requested.

Claims 3 and 8 are rejected under 35 USC §103(a) as being unpatentable over Takahashi as modified by LaFontaine as applied to Claims 1 - 2, 5 - 7 and 10 - 12 above, further in view of Erdmann (Andreas Erdmann et al.; “Enhancements in Rigorous Simulation of Light Diffraction from Phase Shift Masks”, 2002, Proceedings of SPIE, Volume 4691, pages 1156 - 1167). Reconsideration and removal of this rejection is respectfully requested.

Claims 4 and 9 are rejected under 35 USC §103(a) as being unpatentable over Takahashi as modified by LaFontaine as applied to Claims 1 - 2, 5 - 7 and 10 - 12 above, further in view of Mack (Chris A. Mack; “Measuring and Modeling Flare in Optical Lithography”, June 2003, Optical Microlithography XVI, Proceedings of the SPIE, Volume 5040, pp. 151-161). Reconsideration and removal of this rejection is respectfully requested.

It is respectfully submitted that in the cited references:

Takahashi discloses the feature of dividing a calculating area into a plurality of areas, getting an average intensity of beam in each of the divided areas, and calculating a weighted average of the average intensity to obtain an amount of local flare;

LaFontaine discloses the feature of convoluting light intensity and PSF to obtain flare;

Erdmann discloses the feature of accurately calculating diffracted light, passed through a phase-shift mask, by the FDTD formulation; and

Mack discloses the feature to add obtained flare to light intensity.

It is respectfully submitted that these references neither disclose or suggest the feature now found in the amended Claims 1, 6, 11 and 12 which concretely specifies “the average value of light intensity”.

The average value of light intensity \bar{I} is disclosed at page 10, line 11 to page 12, line 22 of the specification. Now added to the claims is equation (3) for the average value of light intensity (\bar{I}), where $\bar{I} = \sum_{k=1}^N F_k S_k S_k^* \dots$ and F_k is a weighing factor of diffracted light, " S_k " is the amplitude of the diffracted light, and $F_k = A_k / (\sigma^2 \pi)$ where A_k is the area shared between a circle C (having a radius NA, the numerical aperture of the lens) and a circle S_k (having a radius of the light source with respect to NA); and σ is the radius of the light source with respect to NA, when a circular-shaped lamp is used, and $F_k = A_k / (\sigma^2 \pi - \sigma_1^2 \pi)$ when a ring-shaped lamp is used.

In the description of the present application, suffix "k" in equation (3), which is found on page 10 of the specification and which is now included in claims 1, 6, 11 and 12, represents the order when a photomask is executed with the Fourier transformation. This difference is not merely a difference in wording, but also a difference in meaning.

In view of the amendments to Claims 1, 6, 11 and 12 and the above remarks, it is respectfully submitted that the present claimed invention is patentably distinct and non-obvious in view of the cited references. Removal of the present rejections is respectfully requested.

It is believed that Claims 1 - 12 are now in condition for allowance. Allowance of Claims 1 - 12 is respectfully requested.

If there are any issues of a minor nature remaining, the Examiner is urged to contact Applicants' attorney, the undersigned, at Area Code (202) 659-2930.

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Respectfully submitted,

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